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ABSTRACT

Ways in which teachers organize classrooms when they have more students than microcomputers available to them were investigated as part of the National Survey of School Uses of Microcomputers, which collected data from 1,082 microcomputer-using schools. These schools represent 68% of a nationally representative sample of about 1,600 microcomputer-owning public and non-public elementary and secondary schools with one or more microcomputers for use by teachers or students, that were surveyed between December 1982 and March 1983. Results indicate that: (1) students work at computers individually more often than in pairs or groups, but some form of mutual assistance is more common than strictly solitary activity; (2) social arrangements for using computers are more common at the junior high level; and (3) seatwork is the primary activity of students in a classroom when other students are engaged at the computer. In addition to grade level and subject matter, variables that might influence style of classroom computer use include the number of students in the classroom, the number of computers available, characteristics of the teacher, and characteristics of the schools' students, particularly the computer-using students. This report is the sixth and final in a series based on the national survey. (LMM)

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School Uses of Microcomputers

Reports from a National Survey

Issue No. 6, November 1984

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Henry Jay Becker, Project Director

Center for Social Organization of Schools

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Note for Readers New to this Series

This is the sixth and final interim report from the National Survey of School Uses of Microcomputers. The results presented are based on data from 1,082 microcomputer-using schools, representing 68% of a nationally representative sample of about 1,600 microcomputer-owning public and non-public elementary and secondary schools. These schools, having one or more microcomputers for use by teachers or students, were surveyed between December, 1982 and March, 1983.

We previously reported that as of the survey date--January, 1983--more than half of all schools that owned computers located them in classrooms. The remaining computer-owning schools located their computers only in laboratories or in libraries, where students doing computer work would not be distracted by teacher-led instruction of other students, and where other students would not be distracted by them.

If a classroom contained enough microcomputers for all students to work with a computer at the same time, the distinction between classroom and laboratory use would largely disappear. However, at the time of the survey, almost all (about 6/7) of the elementary school teachers and nearly half of the secondary school teachers who had microcomputers in their classrooms had only one or two of them. Less than 2% of the secondary school teachers with micros in their classrooms had as many as eight microcomputers for classroom use.

Even with eight computers in the classroom, students may spend as much as three-quarters of their time waiting for their turn at the computer. Often, in order to more quickly cycle through all the students in the class, teachers will assign two or more students to a computer at the same time. However, most packaged computer programs available for schools assume that the computer is interacting with only a single student at a time.

Despite frequent pairings and larger groupings, there is still much waiting time, and teachers must find ways to occupy the students not using the classroom's computers. Options include "whole-class" instruction (everyone except the computer-using students having a single focus of attention), individual seatwork, or cooperative work in small groups.

To use computers effectively in traditional classroom instructional settings, teachers must organize classrooms with simultaneous multiple centers of attention. They must engage students who are waiting for their turn at the computer in profitable -- not merely time-consuming -- activities. In this newsletter, we report how teachers organize classrooms when they have more students than microcomputers available to them.

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Students work at computers individually more often than in pairs or groups, but some form of mutual assistance is more common than strictly solitary activity.

Teachers at elementary and secondary levels assign students to computer work in similar ways. (See Table 1.) At both levels, about one-third of the time that students spend at the computer involves private study--they work alone and interact minimally with other students. In another third of the time pairs of students work together at each computer. The remaining time is spent in one of two ways: students work individually, but receive a lot of help from other students (about 20% of the total time); and students work in groups of more than two at each computer.

Combining these categories in different ways, students spend slightly more than half of their computer time (54%) working individually rather than in pairs or in groups; but most of the time that students work at computers (67%) they are in a social situation anyway, either working in pairs or groups or getting frequent help while doing individual work.

This mixture of activity reflects the average over all respondents. And although there are important differences among teachers, schools in which computers are located in classrooms show similar patterns to schools that locate computers only in other places. There is somewhat more private study in classrooms (35% vs. 30%) and somewhat less use of paired students (29% vs. 33%), but the differences are small.

Table 1: How Many Students Use One Computer at the Same Time? [1]

	Individual (Private) Use	Individual w/Frequent Mutual Help	Pairs of Students	Groups of 3+ Students
Elementary				
Mean % of time that students use computers	36%	19%	31%	14%
Percent reporting this use is...				
"All" or "most of the time"	43%	13%	34%	15%
"Less than 10% of the time"	11%	26%	16%	43%
Secondary				
Mean % of time that students use computers	32%	21%	30%	17%
Percent reporting this use is...				
"All" or "most of the time"	31%	15%	34%	15%
"Less than 10% of the time"	14%	21%	14%	39%

Note

[1] Universe: Teachers who were the primary computer-using teacher at their school.

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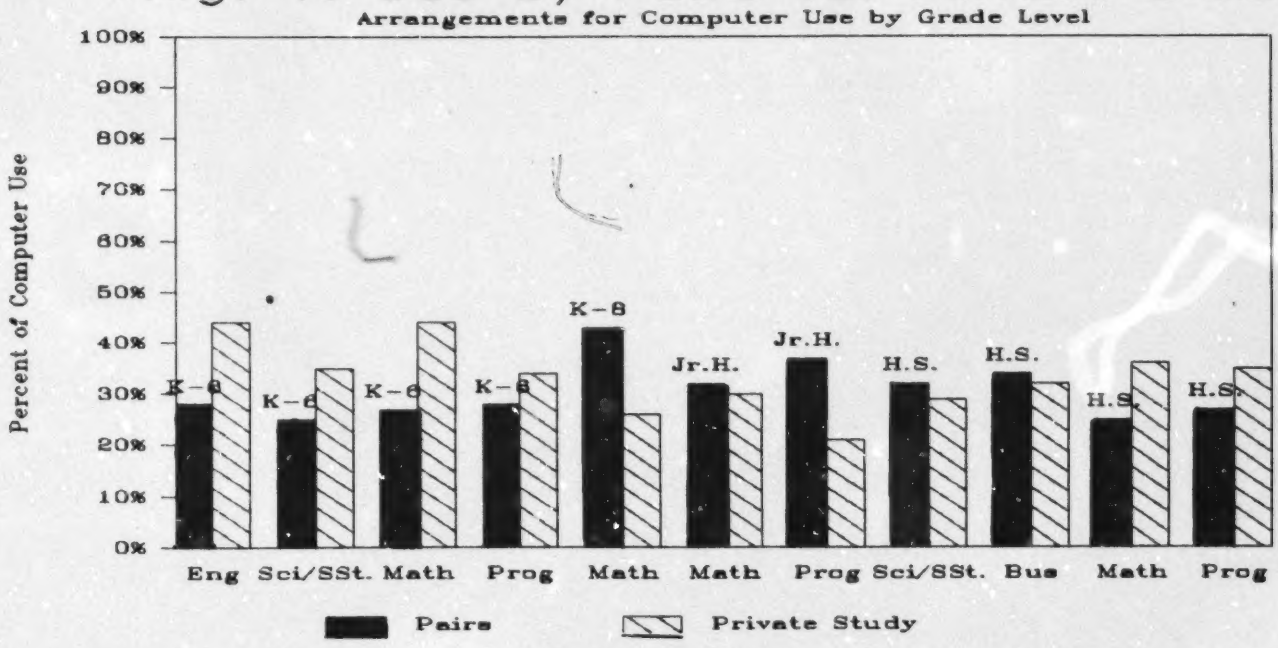
Fig. 1: Use by Pairs vs. Private Study



Social arrangements for using computers are more common at the junior-high level.

Arrangements for student use of computers vary significantly among schools covering different grade levels and by subject taught. Computer-using teachers in middle- and junior-high schools and those in K-8 schools (who primarily use computers with grades 6 to 8) report greater use of paired activity than independent individual activity; whereas teachers of both older and younger students report the reverse. (See Figure 1.)

For example, in mathematics instruction, teachers in K-8 schools have students spend 43% of their computer time in paired activity; while K-6 computer-using teachers have their somewhat younger students spend only 25% of their math computer time in paired use. Junior high computer programming classes spend 37% of their computer time in pairs, but only 26% of senior high programming time is spent in pairs. (See Figure 2.)

When students work at computers individually, their teachers generally expect them to work by themselves, obtaining only occasional help from other students. However, in junior high computer programming classes, teachers expect students working individually to get frequent help from their peers as much as they expect them to work on their own. Of the time that students spend working individually at computers, the proportion that is spent in "frequent peer helping" is about 50% for junior high programming classes but only about 40% for other levels of programming or mathematics instruction and as little as 25% for elementary school English classes. (See Figure 3.)

Thus, compared to teachers of other age levels, teachers of young adolescents seem to find that social contact among students using computers is advantageous (or unpreventable).

Seatwork is the primary activity of students in a classroom when other students are engaged at the computer.

Teachers using computers in their classrooms must decide how to organize the time of students who are

Fig. 2: Arrangements for Computer Use

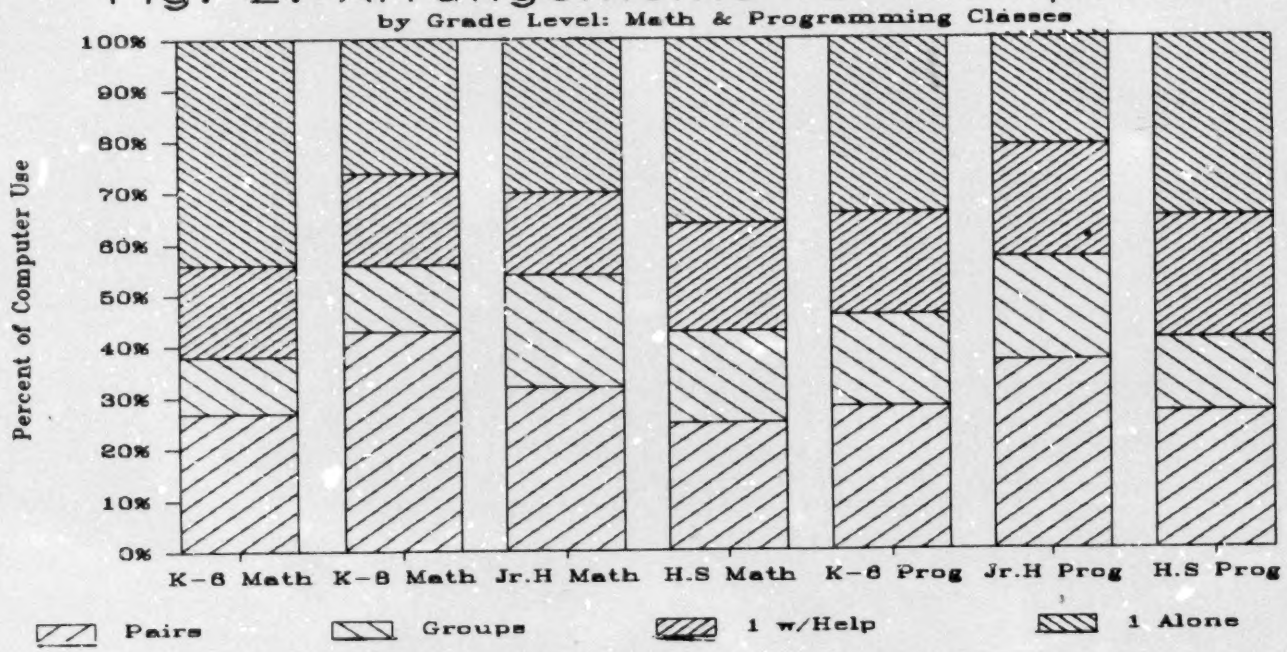
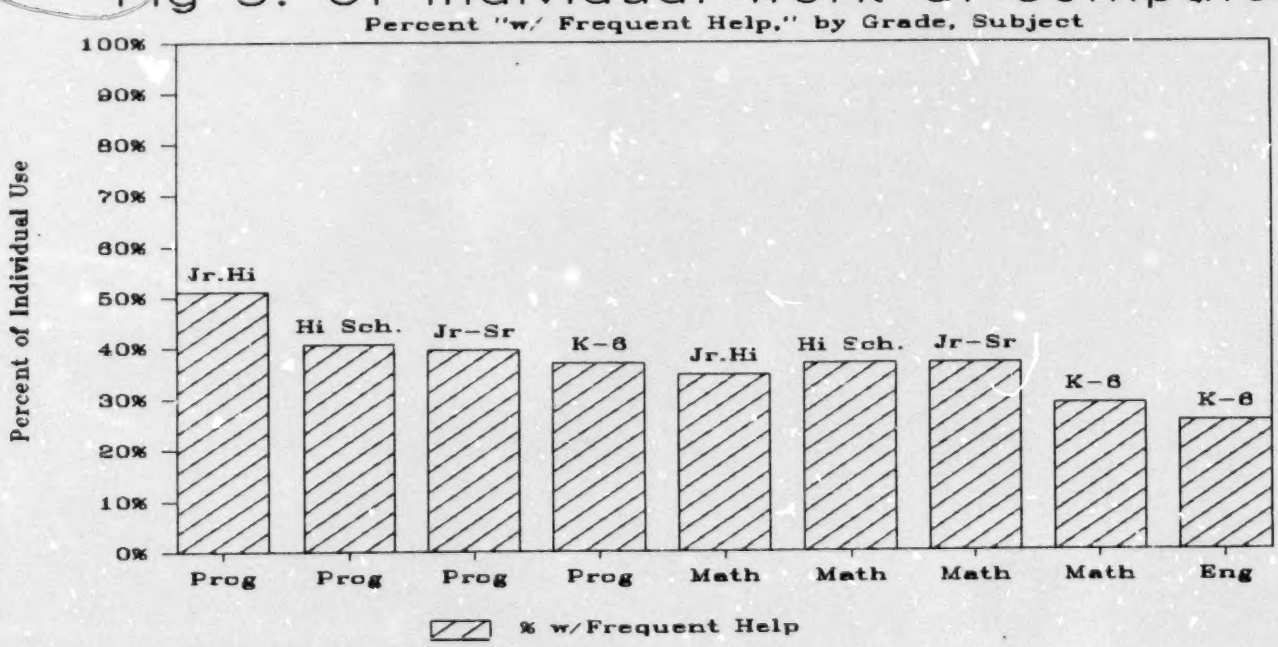


Fig 3: Of Individual Work at Computers



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waiting for their turn at the computers or who are not expected to use them. They can provide direct instruction in a lecture or discussion format; they can break students into work groups for cooperative activity; they can have students work individually at their seats until it is their turn; or they can have students watch those who are working at the computer keyboards.

Many teachers with microcomputers in their classrooms assign students individual seatwork during this waiting time. More than 40% of all student waiting time is spent that way, and about 40% of teachers report that "all" or "most" of the waiting time in their classes is spent this way. (See Table 2.) Few teachers (10% or less) report that "most" waiting time is spent in any of the other ways.

Whole-class lecture or discussion is avoided when in-class computers are in use. Overall, direct instruction is provided during only 15% of the time that computers are in use in classrooms, and about half of the teachers say they never use whole-class activity while the computers are in use. Unfortunately, we have no data on how teachers allocate student activity in the absence of computers, so we cannot say how the presence of computers alters instructional patterns--whether it produces more seatwork and less direct instruction. The plausibility of such an adjustment is suggested by the logistical difficulties of periodically rotating individual or pairs of students to computer activity while simultaneously maintaining a central focus of attention for the rest of the class.

Table 2: How "Waiting" Time is Spent in Classrooms with Computers [1]

	Watching or Helping Computer Users	Individual Seatwork	Working in Small Groups	Whole-Class Lecture or Discussion
Elementary				
Mean % of time that students use computers	14%	44%	28%	13%
Percent reporting this use is "All" or "most of the time"	2%	43%	12%	4%
"Less than 10% of the time"	31%	3%	14%	49%
Secondary				
Mean % of time that students use computers	25%	40%	20%	15%
Percent reporting this use is "All" or "most of the time"	14%	38%	9%	12%
"Less than 10% of the time"	24%	9%	29%	49%

Note

[1] Universe: Schools with one or more computers located in classrooms, rather than solely library or laboratory location. Self-report of the school's primary computer-using teacher.

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Students in junior high school programming classes are more apt to be watching others writing and testing programs than to be doing seatwork while waiting for their turn at the computer. This is not true for other levels of programming instruction nor for other junior high school subject-matter uses of computers.

What other situations lead to different arrangements for using computers and for occupying "waiting" time?

Besides grade level and subject-matter, other variables that might lead to different styles of using computers in classroom situations include the number of students in the classroom, the number of computers that are there, characteristics of the computer-using teacher, and characteristics of the school's students--particularly the computer-using students. Multiple regression procedures were employed to isolate relationships of each variable holding others constant. Table 3 summarizes the data on predictors of teachers' use of different arrangements for assigning students to work on computers; Table 4 presents corresponding data on the choice of waiting time activities.

See pp. 7-8 for Tables 3 & 4.

Not surprisingly, how often teachers put groups of three or more students in front of a single computer is partly a function of how many students and how many computers there are in the classroom. The average classroom in which computers were used for instruction contained only 19 students. But a teacher with 38 students--not unusual in many school systems--would be at least one-third more likely to assign groups of students to each computer than would a teacher in an average-sized classroom. In a classroom with only one computer, students would be grouped for use at least half-again as often as in a classroom with eight computers.

In addition, with eight computers in the room as opposed to just one, the amount of waiting time that students spend watching each other at the computers goes up by at least one-third--primarily at the expense of seatwork time. Neither whole-class instruction nor small group activity during computer-use time seems to be affected by increasing the number of computers in the classroom. Whether the increased use of watching time is profitable probably depends on the teacher's ability to structure the watching activity toward an instructional goal--just as the value of seatwork depends on the quality of the seatwork assignment and on how well that work meshes with the learning needs of the students.

Finally, watching time is more frequent in smaller classes, and whole-class instruction during computer use is more prevalent in larger classes--all of these relationships being net of grade level, subject matter, and teacher and student body characteristics measured.

Teacher and student characteristics that are related to arrangements for using classroom computers and to patterns of waiting activity are also shown in Tables 3 and 4. The more experienced teachers often organize students into small group projects during the time that other students are using the classroom's computers; less experienced teachers do this much less frequently (beta=.26). In contrast, less experienced teachers use both "watching" and "seatwork" activities for waiting time more than more experienced teachers do.

Holding constant school grade levels and subject-matter, women teachers have pairs of students work at computers more than do men teachers (beta=.16). Teachers who were arts-and-sciences majors in college also appear to pair students frequently. In contrast, men teachers and education majors have students work individually at computers more often.

In earlier reports, we emphasized that "above-average" ability students (as defined by each teacher-respondent) were most often the major student users of school microcomputers, and that teachers felt that computers had affected the learning of these children more than they had affected "average" or "below-average" students. In Table 3, our data show that in schools where use is concentrated among above-average students, the primary computer-using teacher reports a

Table 3: Classroom, Student and Teacher Characteristics and Patterns of Classroom Use of Micros[1]

Dependent variables: Percent of time that the given arrangement for assigning students to computers was used.

	Standardized Regression Coefficients[2] for "Percent of Time This Arrangement Was Used"			
	Individual (Private) Use	Individual w/Frequent Mutual Help	Pairs of Students	Groups of 3+ Students
No. of students in classroom				+.15
No. of computers in classrm.	+.08	+.09		-.22
Extent of computer use[3] by...				
Above-average students	+.12			-.21
Average students	-.11		+.16	
Below-average students				
High Socio-economic status student body (Top 25%: yes/no)	-.10			+.12
Teacher is male (yes/nc)	+.11	+.10	-.16	
Teacher was liberal-arts major (rather than educ.)	-.18		+.11	
Teacher's no. of years of teaching experience			-.12	
Teacher uses computers for instruction about... ("Yes" vs "No")				
Math				
Computer Programming		+.13		
English	+.11			
Science/Soc.Stud.				
Business Educ.				-.14
School Grade Level Range				
K-6				-.16
K-8			+.08	
Junior High			+.17	

Notes

[1] Universe: Schools with computers in classrooms; primary computer-using teacher is a classroom instructor.

[2] Regression equations were obtained by forward selection procedures, holding constant the other statistically significant predictors in the table. Probability required to enter = $p < .10$.

[3] Regression coefficients for the three student use variables were obtained from a slightly different equation: one which forced all three variables into the equation. The interpretation of these variables thus becomes "use by (e.g., above-average) students in comparison to other groups of students."

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more "individual-use" pattern than in schools where "average" students get a proportionate share of student computer time. Use by "average" students is instead associated with students using computers in pairs (beta=.16). Assigning students in groups of three or more per computer is particularly less likely at schools where above-average students dominate computer use.

The achievement level of the primary computer-using students also relates to what the other students in the class do while the computers are in use. In schools characterized by dominant use by above-average students, more seatwork is assigned to the non-computer-using students. It could be that using computers is often a reward to students who complete seatwork assignments faster. On the other hand, seatwork is also somewhat more common in classrooms at schools where the below-average students have more use of computers; but seatwork and absence of group work may be a common pattern at schools with many low-achieving students independently of how they might use computers.

We can also identify relationships between subject-matter taught and method of organizing classrooms in which computers are used. Net of other factors, teachers who use com-

Table 4: Classroom, Student and Teacher Characteristics[1] and Time Spent While Other Students are Using Computers

Dependent variables: Percent of time that the teacher used this method for handling students who were not using a classroom computer at the time other students were doing so.

	Standardized Regression Coefficients[2] for "Percent of Time This Method Was Used"			
	Watching or Helping	Individual Seatwork	Working in Small Groups	Whole-class Activity
No. of students in classroom	-.13			+.11
No. of computers in classrm.	+.20	-.10		
Extent of computer use[3] by...				
Above-average students	-.11	+.14	-.10	+.07
Average students		-.11		+.12
Below-average students		+.10	-.14	
Teacher is male (yes/no)			-.08	
Teacher was liberal-arts major (rather than educ.)	+.11			
Teacher's no. of years of teaching experience	-.10	-.13	+.26	
Teacher uses computers for instruction about... ("Yes" vs "No")				
Math	+.18	-.09		
Computer Programming				
English	-.16	+.22		
Science/Soc.Stud.	-.10	-.14	+.15	+.14
Business Educ.			+.12	
School Grade Level Range				
K-6	-.08		+.18	
K-8	-.08	+.10		
Junior High				+.12

Notes

See Table 3.

puters in their mathematics courses (as distinct from computer courses per se) have students watch each other at computers more than do teachers who use computers in other subjects. Science teachers, more than others, attempt to do whole-class instruction and to have students work in small groups during the time that other students are using computers in the classroom. In English instruction, students more often do seatwork while awaiting their turn at the computer. Finally, computer programming teachers report more "individual use with a great deal of mutual help" situations than do teachers of other subjects.

Classroom social arrangements and teacher-perceived learning and enthusiasm.

With our survey data, we cannot measure whether grouping students at the computer is better or worse than having them work individually under the given circumstances. At best, we can examine whether teachers whose students work in pairs or groups believe that their students have more positive learning or attitudinal outcomes than do teachers whose students work by themselves.

Unfortunately, several factors hinder our ability to make definitive statements about such relationships. First, most of our teacher assessments of the computer's impact are at the school level (e.g., "as a result of having a computer at your school, has there been much more..."), but the questions about the social arrangements were asked only of the responding teacher's own use. Secondly, what might be seen as an effective arrangement for one use of computers--say, teaching programming to high school students--might not be seen so positively for another use--e.g., drill-and-practice with elementary school students. Thus, the analysis must be limited to those schools where the one teacher's use is essentially synonomous with the school's use, and analysis must be done separately by grade level and primary computer function (i.e., programming vs. traditional instruction).

This means that even though nearly 1,100 computer-using teachers responded to the survey, these restrictions made it difficult to find a category of schools large enough to provide statistically reliable results about the relationship between the teacher's assignment practices and teacher-perceived outcomes.

However, our sample does contain 120 secondary schools where the conditions were appropriate for analysis: the teacher-respondent was among only one or two regular instructional users of the school's equipment, the equipment was located in classrooms only--not laboratory situations; and the primary instructional use of computers was fairly similar--teaching computer programming and computer literacy. For other groups defined by school grade levels and primary computer function, any conclusions must be regarded as very tentative.

In teaching programming to secondary school students, student enthusiasm was reported to have improved most where students worked at the

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computer individually and without disturbance. Enthusiasm seems to have been least improved for these programming students where students worked in pairs. Also, secondary school programming instructors whose students worked individually reported more perceived learning--whether by above-average, average, or below-average students--when students worked at their programming tasks individually rather than in pairs or groups. These results held up even after controlling for the number of computers available to these students and for the overall extent that the teacher reported using computers. (See Table 5.)

This is not to say that computers are always best used by students working individually. Although the number of elementary schools that could be analyzed was quite small, the data seemed to indicate that, at this level, teachers perceived enthusiasm to be superior when students worked at computers cooperatively rather than individually, and learning was greatest for drill-and-practice activity when this was done in pairs or groups. (However, the elementary school data is based on only 32 drill-and-practice-emphasizing schools and 46 computer-literacy-emphasizing schools.)

Table 5: Teacher-Perceived Student Enthusiasm and Learning by Patterns of Classroom Use of Micros[1]

(Selected Secondary School Computer Programming Sites)

	Standardized Regression Coefficients[2] for Perceived Changes in the Following due to Having Micros at School:			
Percent of Time that Students Use Computers	Student Enthusiasm for School	Learning by Below-Average Students	Learning by Average Students	Learning by Above-Average Students
Individually, with little peer help	+.19*	+.17*		
Individually, with frequent peer help	+.13		+.15	+.13
In pairs	-.22*		-.13	-.18*
In groups of 3 or more	-.20*	-.18	-.13	

The students not using computers work in small groups (rather than doing seatwork or watching computer-users or engaged in whole-class activity)	+.22*		+.16	+.28**

Notes

[1] Universe: Secondary schools with computers in classrooms only; primary computer-using teacher is at most one of two regular teacher-users; programming use reported to be more intensive than drill-and-practice use of computers. (N=120)

[2] Each result in this table is from a separate regression equation in which the following variables were forced into the equation prior to the "social arrangement" variable: extent of use of computers by above-average students, by average students, and by below-average students, percent of time that this teacher's first class of the day made use of computers, the number of computers at the school, and the number of computers available in this classroom. Only relationships greater than |.12| are shown. Beta coefficients statistically significant at $p<.05$ are starred.

Attitudinal and perceived learning outcomes seem to be less affected by alternative arrangements for the students not currently using their classroom computer than by the number of students assigned to use one computer at one time. However, secondary school programming instructors reported more improvement in student enthusiasm and more learning by average and above-average students if the students awaiting their turns at the computer were working in groups--perhaps jointly designing programs or helping one another figure out how to code a computer program. (See Table 5.)

Thus, for secondary school programming instruction, at least, it may be better to have students work in groups away from the computer, but have them work individually at the computer.

This concludes the series of interim reports from the National Survey of School Uses of Microcomputers conducted during the 1982-83 school year. Announcement of the publication of the study's final report--a report that will contain many tabulations that have not appeared in these preliminary reports--will be provided to all subscribers of this newsletter. Such announcement will be forthcoming during Spring, 1985.

During the same period, the Center for Social Organization of Schools, under the sponsorship of the National Institute of Education and the National Center for Education Statistics, will be conducting a Second National Survey of Instructional Uses of School Computers. This new survey will provide more up-to-date descriptive information and more detailed data about curriculum-specific environments in which computers are used in schools. Data from this second survey will begin to become available in the second-half of 1985.

MICROCOMPUTERS IN THE CLASSROOM

DREAMS AND REALITIES

Henry Jay Becker
Center for Social Organization of Schools
The Johns Hopkins University

In this 64-page booklet, Dr. Becker addresses the problems and possibilities associated with using microcomputers in the classroom. Focusing on different instructional techniques and general social considerations, he argues that certain preconditions are needed before microcomputers can be used effectively for student instruction. He concludes with a summary of recommendations for those involved with educational uses of microcomputers, based on the dreams people hold for computers in the classroom and the realities these dreams must confront.

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